MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EEL2026 – POWER TRANSMISSIONS AND DISTRIBUTIONS

(LE)

03 MARCH 2020
2.30 p.m – 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages including the cover page with 4 Questions only.

2. Answer **ALL** questions. The distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Underground lines are most commonly used to feed urban substations in high load density areas. The highest underground transmission line voltage is 525 kV. The cost of an underground line is 9 to 15 times the cost of an overhead line. State **THREE** reasons why the costs of underground cables are high. [3 marks]

(b) An aluminum conductor is composed of 35 strands each having a diameter of 0.25 cm. Calculate the DC resistance in ohms per kilometer at 20°C and 70°C. The resistivity of aluminum $\rho = 2.5 \times 10^{-8}$ Ω-m. Assume that the increase in resistance due to spiraling is 2%, and temperature constant of aluminum, T = 228. [5 marks]

(c) The conductor of a single-phase 50 Hz line is a solid round aluminum wire having a diameter of 0.5 cm. The conductor spacing is 4 m. Neglecting the skin effect,

(i) determine the inductance of the line in mH per km. [4 marks]

(ii) how much is the inductance due to internal flux linkage. [2 marks]

(iii) what is the effect of the spacing between the conductors on the inductance of the line? [1 mark]

(d) Normally for voltage levels above 230 kV, bundled conductors are used. Bundled conductors consist of two, three or four conductors. State **THREE** advantages of bundled conductors. [6 marks]

(e) Given that the conductor diameter is 1.5 cm and the spacing between the conductors is 8 m, calculate the capacitive reactance and susceptance per kilometer of a single-phase line operating at 50 Hz. [9 marks]

Question 2

(a) A 345 kV, 50-Hz, three-phase transmission line is 150 km long. The resistance per phase is 0.04 Ω per km and the inductance per phase is 0.8 mH per km. The shunt capacitance is 0.015 μF per km. The receiving end load is 270 MVA with 0.8 power factor lagging at 325 kV. Use the medium line model to calculate the voltage, current and power at the sending end and the voltage regulation. [18 marks]

(Hint: A, B, C and D constants are given as:

$$A = 1 + \frac{Y\angle\varphi . Z\angle\theta}{2} = D$$

$$B = Z\angle\theta$$

$$C = Y\angle\varphi\{1 + \frac{Y\angle\varphi . Z\angle\theta}{4}\})$$

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(b) A 400-kV, three-phase transmission line is 270 km long. The series impedance, z = $0.4 \angle 83.58$ Ω/ph/km and shunt admittance y = $5 \times 10^{-6} \angle 90$ S/ph/km. Calculate the Z' of the equivalent-π circuit of the line, and compare it with the Z of nominal-π circuit. [7 marks]

Question 3

(a) There are two major types of insulators used in overhead transmission lines to insulate the bare conductors from the towers. Name these **TWO** types of insulators, briefly highlight where these insulators are installed. [2+4 marks]

(b) Figure Q3 shows a string of five insulators.

(i) Obtain the Kirchhoff's Current Law (KCL) equations for nodes *P*, *Q*, *R* and *S* in terms of E_5, E_4, E_3, E_2, E_1 and *E*. [10 marks]

(ii) The pin-to-pin capacitance of each unit is *m* times the pin-to-earth capacitance. If $m = 8$, obtain the voltage distribution across each insulator in the string as the percentage of voltage of the conductor to earth and the string efficiency. [9 marks]

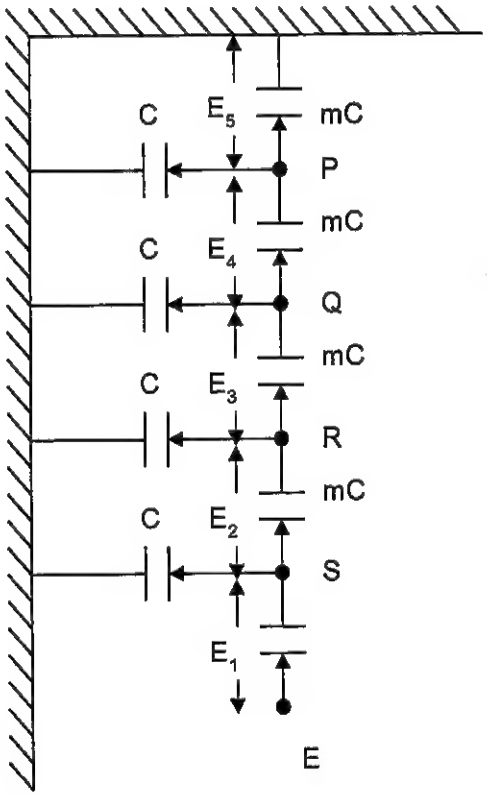

Figure Q3

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Question 4

(a) List out **FOUR** factors affecting the selection of the rating of a primary feeder. [4 marks]

(b) A 240V radial distributor is 100 m long and has a resistance of 0.0005 Ω per meter supply and return. Four loads A, B, C and D rated at 30A, 30A, 60A and 80A are fed from the cable at distances of 30 m, 20 m, 25 m and 25 m respectively. Calculate the total current drawn from the supply, the current in the cable between each load, and the voltage at load D if all the loads are connected. [10 marks]

(c) A 33 kV voltage is applied to a three-phase distributor having R = 4 Ω and X = 5 Ω per phase. At the end of the line is a balanced load of power, P in MW at 0.6 power factor leading. Determine the value of P to make the load voltage equal to the supply voltage. [6 marks]

End of Paper.